Redetermination of the structure of 7-chloro-1,3-dihydro-1-methyl-5-phenyl-1,4-benzodiazepin-2(3*H*)-one, $C_{16}H_{13}ClN_2O$

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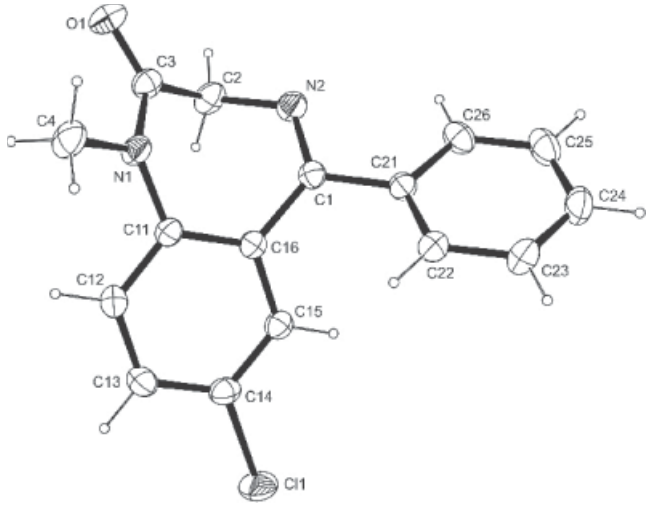
Received October 31, 2012, accepted February 08, 2013, available online April 26, 2013, CCDC no. 1267/3957



Abstract

$C_{16}H_{13}ClN_2O$, monoclinic, $P2_1/c$ (no. 14), a = 7.9510(2) Å, b = 13.2274(3) Å, c = 12.8923(3) Å, β = 90.172(1)°, V = 1355.9 Å^3, Z = 4, $R_{gt}(F)$ = 0.0314, $wR_{ref}(F^2)$ = 0.0834, T = 200 K.

Table 1. Data collection and handling.

Crystal:	yellow blocks, size 0.29×0.37×0.47 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	2.78 cm^{-1}
Diffractometer, scan mode:	Bruker APEX-II CCD, φ and ω
$2\theta_{max}$:	56.68°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	23240, 3380
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\,\sigma(I_{obs})$, 3164
$N(param)_{refined}$:	182
Programs:	SHELX [5], ORTEP-3 [6], MERCURY [7], PLATON [8]

Source of material

Diazepam was obtained as a gift sample from R. L. Fine Chem., Bengaluru, India. X-ray quality crystals were obtained from DMSO by slow evaporation.

Experimental details

Carbon-bound hydrogen atoms were placed in calculated positions (C–H 0.95 Å for aromatic carbon atoms and C–H 0.99 Å for the methylene group) and were included in the refinement in the riding model approximation, with U_{iso}(H) set to 1.2U_{eq}(C). The H atoms of the methyl groups were allowed to rotate with a fixed angle around the C–C bond to best fit the experimental electron density (HFIX 137 in the SHELX program suite [5]), with U_{iso}(H) set to 1.5U_{eq}(C).

Discussion

Diazepam is mainly used to treat anxiety, insomnia, and symptoms of acute alcohol withdrawal. It is also used as a premedication for inducing sedation, anxiolysis or amnesia before certain medical procedures. In addition, it possesses anticonvulsant, hypnotic and skeletal muscle relaxant properties. The pharmacological action of diazepam enhances the effect of the neurotransmitter GABA by binding to the benzodiazepine site on the $GABA_A$ receptor (via the constituent chlorine atom) leading to central nervous system depression [1, 2]. The structure of the title compound has been reported earlier [3], however, at room temperature only. The C=N bond is *Z* configured and the length of this bond was measured at 1.2847(13) Å. Amide-type resonance slightly shortens the intracylic N–C(O) bond, the respective value is found at 1.3717(13) Å. The coordination geometry around N1 can be described as trigonal-planar, the least-squares plane defined by the non-hydrogen atoms of the amide group and the atoms immediately bonded to it –C_{ar}–CH_3–N–C(O)–CH_2– is essentially planar (r.m.s. of all fitted atoms = 0.0624 Å) with the aromatic carbon atom deviating most from this common plane by –0.088(1) Å. According to a puckering analysis [4], the seven-membered heterocycle adopts a boat-like conformation in which the intracyclic methylene group acts as the flagpole position. The least-squares planes defined by the respective carbon atoms of the individual aromatic moieties intersect at an angle of 54.03(5)°. In the crystal, C–H···O contacts whose range falls by up to 0.17 Å below the sum of van-der-Waals radii of the atoms participating are apparent. These are exclusively supported by hydrogen atoms on the non-halogenated phenyl moiety. The more pronounced shortening with regards to the van-der-Waals cut-off criterion is apparent for the hydrogen atom in *para*-position to the heterocyclic substituent on this phenyl group. In addition, a C–H···π contact stemming from a hydrogen atom on the chlorinated and annealated aromatic moiety and applying the π system of the non-substituted phenyl moiety in a neighbouring molecule as the acceptor can be detected.

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Table 2. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	*x*	*y*	*z*	U_{iso}
H(2A)	4*e*	–0.2655	0.4694	0.1157	0.033
H(2B)	4*e*	–0.4179	0.5424	0.0836	0.033
H(4A)	4*e*	–0.3069	0.6266	0.4222	0.048
H(4B)	4*e*	–0.1390	0.5660	0.4511	0.048
H(4C)	4*e*	–0.3143	0.5072	0.4418	0.048
H(12)	4*e*	–0.0607	0.4002	0.3975	0.033
H(13)	4*e*	0.1897	0.3175	0.3573	0.034
H(15)	4*e*	0.2376	0.4910	0.1008	0.026
H(22)	4*e*	0.2739	0.6652	0.1699	0.032
H(23)	4*e*	0.4599	0.7737	0.0842	0.043
H(24)	4*e*	0.3856	0.8461	–0.0743	0.043
H(25)	4*e*	0.1219	0.8122	–0.1467	0.041
H(26)	4*e*	–0.0656	0.7051	–0.0621	0.032

Table 3. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	*x*	*y*	*z*	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
Cl(1)	4*e*	0.41670(4)	0.33320(2)	0.19107(3)	0.0297(2)	0.0310(2)	0.0515(2)	0.0119(1)	0.0052(1)	–0.0000(1)
O(1)	4*e*	–0.48617(9)	0.58437(7)	0.26903(7)	0.0200(4)	0.0375(4)	0.0378(4)	0.0025(3)	0.0028(3)	–0.0058(3)
N(1)	4*e*	–0.2148(1)	0.54469(7)	0.30329(7)	0.0204(4)	0.0297(4)	0.0207(4)	0.0013(3)	0.0031(3)	–0.0015(3)
N(2)	4*e*	–0.1923(1)	0.61256(7)	0.08544(7)	0.0220(4)	0.0328(5)	0.0219(4)	0.0001(3)	–0.0012(3)	0.0010(3)
C(1)	4*e*	–0.0370(1)	0.60258(7)	0.11144(7)	0.0212(4)	0.0222(4)	0.0175(4)	0.0004(3)	0.0007(3)	–0.0009(3)
C(2)	4*e*	–0.3123(1)	0.53824(9)	0.12427(8)	0.0197(5)	0.0368(6)	0.0256(5)	–0.0043(4)	–0.0024(4)	–0.0034(4)
C(3)	4*e*	–0.3492(1)	0.55732(8)	0.23759(8)	0.0201(4)	0.0233(5)	0.0277(5)	–0.0026(4)	0.0006(4)	–0.0023(4)
C(4)	4*e*	–0.2464(2)	0.5626(1)	0.41376(8)	0.0305(5)	0.0425(6)	0.0227(5)	0.0016(5)	0.0057(4)	–0.0032(4)
C(11)	4*e*	–0.0639(1)	0.49539(8)	0.27310(7)	0.0184(4)	0.0224(4)	0.0219(4)	–0.0013(3)	0.0005(3)	–0.0003(3)
C(12)	4*e*	–0.0006(1)	0.41877(8)	0.33687(8)	0.0256(5)	0.0295(5)	0.0268(5)	–0.0016(4)	0.0029(4)	0.0078(4)
C(13)	4*e*	0.1479(1)	0.36946(8)	0.31341(9)	0.0272(5)	0.0244(5)	0.0338(5)	0.0011(4)	–0.0016(4)	0.0077(4)
C(14)	4*e*	0.2345(1)	0.39719(8)	0.22480(8)	0.0207(4)	0.0208(4)	0.0320(5)	0.0021(4)	0.0004(4)	–0.0020(4)
C(15)	4*e*	0.1756(1)	0.47284(8)	0.16087(8)	0.0213(4)	0.0220(5)	0.0226(4)	–0.0004(4)	0.0022(3)	–0.0020(4)
C(16)	4*e*	0.0254(1)	0.52329(7)	0.18349(7)	0.0193(4)	0.0196(4)	0.0198(4)	–0.0011(3)	–0.0002(3)	–0.0010(3)
C(21)	4*e*	0.0857(1)	0.67279(7)	0.06172(7)	0.0227(5)	0.0206(4)	0.0199(4)	0.0022(3)	0.0032(3)	0.0000(3)
C(22)	4*e*	0.2426(1)	0.69455(9)	0.10536(9)	0.0222(5)	0.0299(5)	0.0285(5)	0.0003(4)	0.0013(4)	0.0043(4)
C(23)	4*e*	0.3532(2)	0.7592(1)	0.0543(1)	0.0237(5)	0.0375(6)	0.0455(7)	–0.0030(5)	0.0071(5)	0.0055(5)
C(24)	4*e*	0.3092(2)	0.80258(9)	–0.0395(1)	0.0365(6)	0.0314(6)	0.0404(6)	–0.0001(5)	0.0184(5)	0.0066(5)
C(25)	4*e*	0.1529(2)	0.78220(9)	–0.08250(9)	0.0482(7)	0.0292(6)	0.0240(5)	0.0038(5)	0.0082(5)	0.0055(4)
C(26)	4*e*	0.0416(2)	0.71818(8)	–0.03228(8)	0.0349(5)	0.0244(5)	0.0216(5)	0.0018(4)	–0.0011(4)	0.0005(4)

Acknowledgments. Alaloor S. Dayananda thanks the University of Mysore for research facilities.

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